FIELD EMISSION PROPERTIES OF SELECTED SINGLE WALL CARBON NANOTUBE SAMPLES

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Keywords: nanotubes, field emission

Carbon based nanostructures have proven very attractive materials and their properties are very widely investigated.
Our synthesis approach, based on a Hot Filament Chemical Vapor Deposition (HFCVD) system coupled to a powder mixing cell, has proved to be particularly versatile in obtaining a variety of nanostructures. Carbon nanopowders obtained by laser pyrolisis of ethylene/acetylene mixtures are used as carbon source; the reaction with a filament-activated atomic hydrogen plasma allows us to obtain good quality Single Wall Carbon Nanotubes (SWCNT) [1].
We successfully exploited controlled variations of synthesis parameters such as time, powder flux orientation and intensity of hydrogen flux and managed to control tubes' orientations and bundles' dimensions.

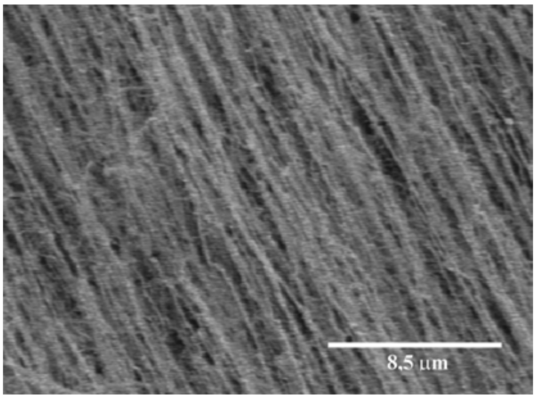

Fig. 1 SEM image of a SWCNT sample showing a very good alignment of the bundles

The influence of different morphologies on field emission behavior constitutes a non secondary key point, both for a deeper understanding of emission phenomenon and for a more precise tuning of the future devices' performances.
Moreover, our synthesis process proved to be substrate selective, so that we are able to obtain selected area growth of SWCNTs [2]: field emission properties of such ordered arrays of emitters constitutes a hot technological spot in view of the wide number of applications [3].
Finally, we are investigating the field emission behavior of a newly synthesized kind of carbonaceous nanostructures made up of SWCNTs covered by a nanocristalline phase identified with diamond [4] whose properties promise to be very interesting.

We set up and tested a home made field emission measurement apparatus: cathode-anode system resembles the plan to sphere set up; their distance can be adjusted by means of a high resolution linear actuator driven by PC and measured by a capacimetric approach; two micrometric knobs allows us to scan over the sample.
We demonstrate the possibility of obtaining very promising results: our actual interest is particularly concerned with reproducibility (i.e. the reliability of the future field emission device) and durability of our samples' performances.

Field emission measures have been carried out on a series of morphologically well defined samples. Our cathodes required a prolonged conditioning period before reaching a reasonably reproducibility of I-V emission curves. Training of samples has been undertaken both by successive potential scans and prolonged application of high fields: as a result of both processes, the maximum current undergoes a slight decrease, I-V curves gets smoother and smoother, Fowler-Nordheim plots gets linear in a wider potential range. The non reproducible features which initially affect emission measures has been interpreted as irreversible modification of samples' surfaces during potential scans such as the field evaporation of absorbed gaseous species [5]: once the cathode gets clean, its emission performances get stable. By keeping our cathodes under high emission current conditions, we verified the durability of the nanotube samples as well: they survived long (up to three full days) to extreme conditions such as high current (at μA level) and low vacuum level (10^{-6} mbar) thus demonstrating the real possibility of using SWCNTs as field emitter in a variety of electronic devices.

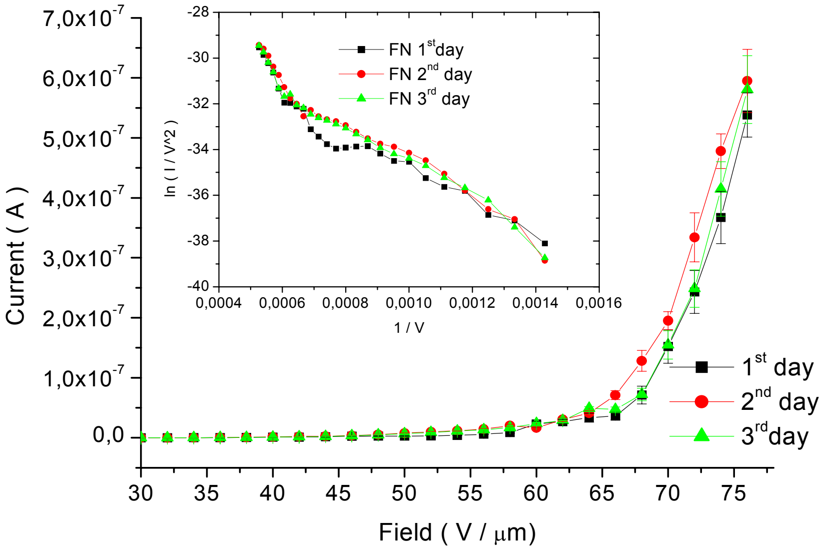

Fig. 2 Field-Current curves showing reproducibility of performances in different measurement days. The inset shows the corresponding Fowler Nordheim plots.

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